USE TRANSISTORS TO MAKE AN OR GATE

CONNECT TWO TRANSISTOR BUFFERS OR YES GATES IN PARALLEL AND YOU GET AN OR GATE. YOU WILL BUILD AN OR GATE. THEN YOU WILL TEST THE GATE TO SEE IF ITS OPERATION MATCHES THE OR GATE TRUTH TABLE.

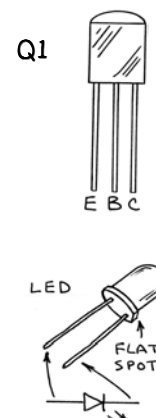
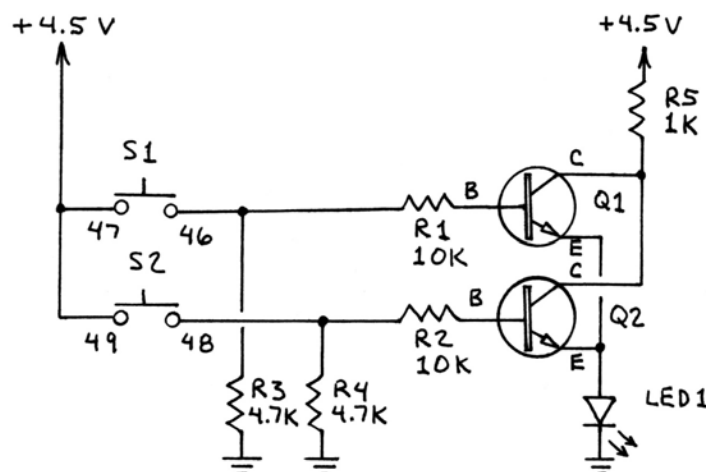
PARTS YOU WILL NEED

R1, R2-10K (BRN-BLK-ORG)
R3, R4-4.7K (YEL-VIO-RED)
R5-1K (BRN-BLK-RED)

Q1, Q2
NPN TRANSISTORS
(9014)

LED 1-RED LED

CIRCUIT DIAGRAM

OR GATE		
S1	S2	LED
OFF	OFF	OFF
OFF	ON	ON
ON	OFF	ON
ON	ON	ON

1. BUILD THE CIRCUIT

1. ☐ PUSH THE POWER SWITCH TO OFF.
2. ☐ INSERT Q1 AT M23 (E), K23 (B) AND I23 (C).
3. ☐ INSERT Q2 AT T23 (E), R23 (B) AND P23 (C).
4. ☐ INSERT LED 1 BETWEEN T21 (ANODE) AND GROUND (CATHODE).
5. ☐ INSERT R1 BETWEEN K20 AND K21.
6. ☐ INSERT R2 BETWEEN R20 AND R21.
7. ☐ INSERT R3 BETWEEN K18 AND GROUND.
8. ☐ INSERT R4 BETWEEN R18 AND GROUND.
9. ☐ INSERT R5 BETWEEN I24 AND A24.
10. ☐ CONNECT M25 TO T25 (WHT WIRE).
11. ☐ CONNECT I25 TO P25 (WHT WIRE).
12. ☐ CONNECT A21 TO V3 (+4.5V) (WHT WIRE).
13. ☐ CONNECT SPRINGS 47 AND 49 (WHT WIRE).
14. ☐ CONNECT SPRING 46 TO K16 (RED WIRE).
15. ☐ CONNECT SPRING 48 AND R16 (RED WIRE).
16. ☐ CONNECT SPRING 47 TO V3 (+4.5V) (BLU WIRE).

2. TEST THE CIRCUIT

CAREFULLY CHECK YOUR WIRING. THEN PUSH THE POWER SWITCH ON. NOW TEST THE CIRCUIT TO SEE IF THE LED OUTPUT MATCHES THE TRUTH TABLE. PRESSING S1 OR S2, OR BOTH S1 AND S2, WILL SWITCH THE GATE ON AND LIGHT THE LED. OTHERWISE THE LED WILL BE OFF.

HOW THE OR GATE WORKS

TRANSISTORS Q1 AND Q2 ARE CONNECTED IN PARALLEL LIKE THE TWO SWITCHES IN A SWITCH OR GATE. WHEN EITHER OR BOTH Q1 AND Q2 ARE SWITCHED ON, THE LED SWITCHES ON AND GLOWS. WE USED THE DPDT SWITCH TO CONTROL THE INPUTS OF THE TRANSISTOR YES AND NOT GATES. AS WITH THE AND GATE AND THE NAND GATE, WE NEED SEPARATE INPUT SWITCHES. R3 AND R4 PULL THE BASES OF Q1 AND Q2 DOWN TO GROUND (LOW OR 0). CLOSING S1 OR S2 APPLIES CURRENT TO THE BASES OF Q1 AND Q2 AND SWITCHES THEM ON (HIGH OR 1).

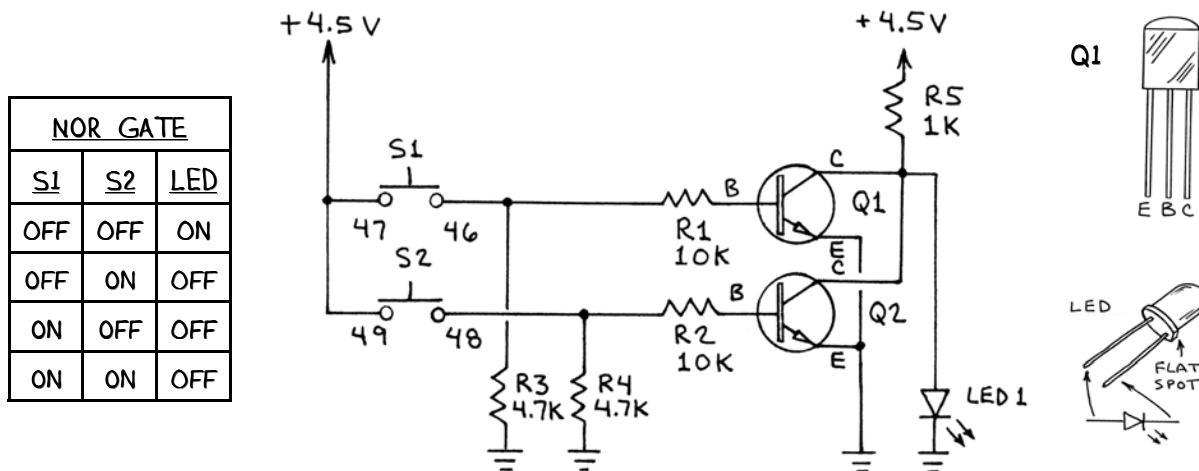
USE TRANSISTORS TO MAKE A NOR GATE

A 2-TRANSISTOR OR GATE CAN ALSO BE USED AS A NOR GATE. YOU WILL MODIFY AN OR GATE TO FUNCTION AS A NOR GATE. THEN YOU WILL TEST THE GATE TO SEE IF ITS OPERATION MATCHES THE NOR GATE TRUTH TABLE.

PARTS YOU WILL NEED

THIS CIRCUIT IS A MODIFIED VERSION OF THE 2-TRANSISTOR OR GATE ON PAGE 22.
NO ADDITIONAL PARTS ARE REQUIRED.

CIRCUIT DIAGRAM

NOR GATE		
S1	S2	LED
OFF	OFF	ON
OFF	ON	OFF
ON	OFF	OFF
ON	ON	OFF

1. MODIFY THE OR GATE CIRCUIT ON PAGE 22

MODIFY THE OR GATE CIRCUIT ON PAGE 22 BY FOLLOWING THESE STEPS:

1. ☐ PUSH THE POWER SWITCH TO OFF.
2. ☐ MOVE LED 1'S ANODE FROM R21 TO T26.
3. ☐ CONNECT T28 TO I22 (RED WIRE).
4. ☐ CONNECT T21 TO GROUND (WHT WIRE).

2. TEST THE CIRCUIT

BE SURE ALL THE CONNECTIONS ARE CORRECT. THEN PUSH THE POWER SWITCH TO ON. THE LED WILL GLOW. NOW TEST THE CIRCUIT TO FIND OUT IF THE LED MATCHES THE TRUTH TABLE. WHEN EITHER S1 OR S2, OR BOTH S1 AND S2, ARE PRESSED, THE LED WILL BE OFF. ONLY WHEN BOTH S1 AND S2 ARE OFF (LOW) WILL THE LED GLOW.

HOW THE NOR GATE WORKS

JUST AS YOU USED AN <u>AND GATE</u> AS A <u>NAND GATE</u>, THIS CIRCUIT USES AN <u>OR GATE</u> AS A <u>NOR GATE</u> BY MOVING THE LED. WHEN BOTH S1 AND S2 ARE OPEN, BOTH Q1 AND Q2 ARE OFF, AND CURRENT FLOWS THROUGH THE LED. THE LED GLOWS (HIGH OR 1) . WHEN EITHER S1 OR S2 IS CLOSED, Q1 OR Q2 SWITCHES ON AND DIVERTS THE CURRENT FROM FLOWING THROUGH THE LED. THE LED THEN SWITCHES OFF (LOW OR 0). R3 AND R4 PULL THE BASES OF Q1 AND Q2 TO GROUND, THUS KEEPING THEM SWITCHED OFF UNTIL EITHER S1 OR S2 IS CLOSED.

STILL MORE ABOUT LOGICAL 0 (LOW) AND LOGICAL 1 (HIGH)

THE TRANSISTOR GATE CIRCUITS YOU HAVE BEEN BUILDING USE THE <u>POSITIVE LOGIC SYSTEM</u> IN WHICH OFF = LOW = 0 AND ON = HIGH = 1. LOGIC CIRCUITS CAN ALSO USE THE <u>NEGATIVE LOGIC SYSTEM</u> IN WHICH OFF = HIGH = 1 AND ON = LOW = 0.